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PROVISIONAL SPECIFICATION
FOR A PROVISIONAL PATENT

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Invention Title: **Magnetic Holding Device**

The following statement is a description of this invention

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Magnetic Holding Device

Technical Field

This invention relates to a magnetic holding device and a process for use therein. More particularly, in one aspect this invention relates to a magnetic holding device for use with a ferrous metal-backed or ferrous metal-incorporated impression die in a stamping, blocking, embossing or debossing process.

Background Art

Stamping, blocking, embossing or debossing processes (generically referred to hereafter as "graphic art design processes"), typically involve the use of stamping or blocking dies prepared by etching or engraving a desired design in the outer surface of a metal plate, normally magnesium, aluminium, copper, brass or steel. It has been a standard in the field to make the dies of a sufficient thickness (about 6 to 7mm depending on the jurisdiction) to withstand the rigours of the graphic art design process over time. In North, Central and South America and in the United Kingdom the standard is ¼ inch. Elsewhere the standard is 7mm.

Motivated by cost imperatives, brass, copper, magnesium, aluminium or polymeric (or composites thereof) steel-backed die plates of minimal thickness (say 0.5 to 1mm) were developed for use in graphic art design processes. In particular, steel-backed photopolymer die plates have been developed in which a hardened photopolymeric composition bearing the required design cladded onto a thin steel backing plate has been developed. The minimal amount and the low cost of the materials included in such steel-backed die plates has led to their increasing use as the preferred die in such stamping processes. However, due to their relative lack of depth, it is necessary to include a solid spacer plate between the die plate and a chase of the stamping or embossing machine to enable the continued use of existing equipment without modification. Such spacer plates have generally been

required to be secured to the chase using mechanical attachment means such as a screw down locking arrangement.

During the graphic art design process the die plate is subject to significant forces which will laterally shift the die plate relative to the spacer plate unless the die plate and spacer plate are clamped together. To avoid the necessity for clamping means such as the mechanical attachment means referred to above, spacer plates have been described having embedded permanent magnets to hold the steel backed die plate in position during the graphic art design process. Such a spacer plate is described in US patent No. 5,904,096 (Fawcett *et al*). The spacer plate in Fawcett *et al* is made of non-ferrous material which has a short effective lifetime due to the softness of the metal.

An arrangement described in US patent No. 6,152,035 (Scholtz *et al*) claims to more firmly affix the die plate to the spacer plate described in Fawcett. In the Scholtz *et al* arrangement the permanent magnets are described as being made of a material having a superior temperature of remanence. This enables the spacer plate to exhibit strong magnetic attractive force at the high temperatures required in, for example, hot foil stamping processes.

However, the use of square magnets arranged in a "doggy bone" arrangement in Scholtz *et al* is considered counter-productive in that the magnetic flux generated by the magnetic material per unit volume is less than optimal. It is considered that optimal magnetic flux is obtained using spaced circular magnets, such as disc or cylindrical shaped magnets. The spacer plate in Scholtz *et al* projects a magnetic field in one direction only corresponding to the upper face thereof. Accordingly, other attachment means such as mechanical attachment means are required to fix the spacer plate to the chase.

Also the production of the Scholtz *et al* plate is labour intensive due to the amount and difficulty of the machining involved. Moreover, the disadvantages inherent in the use of non-ferrous materials to form the spacer plate render the arrangement

described in Scholtz *et al* less than satisfactory. It is anticipated that the manufacturing costs of the Scholtz *et al* plate will exceed those made in accordance with the present invention by a factor of 10.

It has been found that spacer plates made from non-ferrous metals or their alloys such as copper, brass or aluminium display insufficient resiliency during long production runs, leading to early cratering of the plate and consequent physical failure of the magnets embedded therein. The repeated impact of the die on the spacer plate leads to concave depressions in the upper surface of the spacer plate. Such craters become problematic and begin to affect the efficacy of the stamping process when they become as deep as 1/40,000 to 1/60,000 inch (about 1/16,000 to 1/24,000mm). Accordingly, cratering is a serious problem in the industry and requires the regular replacement of spacer plates to maintain efficacy during the graphic art design process.

Relative to steel, these non-ferrous materials such as bronze, brass, copper alloys, aluminium alloys, magnesium alloys, nickel and zinc, are more malleable. This is of importance in processes involving high impact forces in terms of pounds per square inch (psi).

These non-ferrous metals are also currently considerably more expensive than steel products. However, the use of ferrous metals such as steel in the spacer plate has heretofore not been considered an option for magnetic spacer plates due to its magnetic properties and the resultant dissipation of magnetic flux if it is permitted to be generally distributed across the spacer plate.

The above description of the prior art is not intended to be, nor should it be interpreted as, an indication of the common general knowledge pertaining to the invention, but rather to assist the person skilled in the art in understanding the developmental process which lead to the invention.

Accordingly there is a need in the industry for an arrangement which ameliorates one or more of the abovementioned disadvantages.

Disclosure of the Invention

In one broad form the invention provides a magnetic holding device including:

a) a support structure made of an iron alloy and having a substantially planar bearing surface;

b) at least one magnetic or magnetisable region located in said support member; and

c) insulating means made of non-magnetic material interposed between said region and said support structure to resist magnetic induction of, or leakage to, said support structure.

The magnetic holding device may include a range of shapes and configurations depending on the application. For example, where the magnetic holding device is used as a spacer plate in graphic art design processes, the magnetic holding device is preferably in the form of a plate. The magnetic holding device may include two opposed planar surfaces. The magnetic holding device may be square, rectangular or any other shape suitable to the application. In its most common application in graphic art design processes, the magnetic holding device will be in the form of a planar rectangular plate.

The magnetic holding device may vary in its dimensions. For example, in its application as a spacer plate in graphic art design processes the magnetic holding device is preferably between about 4mm and 6.5mm thick, depending to a large extent on the thickness of the die plate to be attached thereto. In other applications, the thickness of the magnetic holding device may vary considerably depending on spacial constraints and the magnetic flux density required in each particular case.

Depending on the dimensions of the graphics art design required to be produced, the bearing surface of the spacer plate may include sizes of about 210 x 150mm, 300 x 210mm (A4 size) or 420 x 300mm (A3 size).

The support structure in general terms defines the dimensions of the magnetic holding device. The support structure includes one or more bores adapted to receive the one or more magnetic or magnetisable regions. Preferably, the support structure is made of steel. Depending on the application, the support structure may be made of mild steel, case-hardened steel, stainless steel and the like. Even magnetic holding devices made of steel will eventually become distorted to the extent that they are no longer useful.

However, a steel support structure will be considerably more durable than present alternatives by a factor of between 20 and 30 times. As a person skilled in the art will appreciate, softer metals will exhibit less fatigue but more malleability and harder metals will exhibit greater resistance to distortion over time, but may exhibit higher instances of fatigue. Accordingly, the iron alloy used will vary in iron, carbon, copper, zinc, etc. content depending on the application.

The at least one magnetic or magnetisable region may include a magnetisable core subject to an electric field to induce magnetism or may be in the form of a permanent magnet. The magnetisable region may be useful in applications where the application of intermittent magnetic force is required. For example, in graphic art design processes it may be useful to place a die plate on the magnetic holding device in suitable alignment as required and then apply the magnetic force to hold the die plate in fixed position until the production run is completed. The power may then be cut off to release the die plate. However, it may be more convenient in many applications to use permanent magnets to form the magnetic region.

In a preferred form of the invention, the magnetic holding device includes a plurality of magnetic or magnetisable regions in spaced relationship with one

another. Depending on the application and the relative magnetic field intensity required, the following factors may be varied:

1. The diameter of the or each region;

2. The depth of the or each region;

3. The separation between regions;

4. The orientation of the magnetic poles to vary the magnetic field intensity surrounding the one or more regions.

5. The particular material used for the magnetic region or the amount of current carried by conductors in the case of magnetisable regions.

Preferably, the one or more magnetic or magnetisable (hereinafter referred to as "magnetic regions") regions have a diameter of 2-10mm. Still more preferably, the at least one magnetic region has a diameter of 3-6mm. Magnetic field intensity per unit volume of magnetic material is maximised by have a plurality of tightly spaced magnets of small diameter. The depth of the magnetic region may vary with and correspond substantially directly with the thickness of the support structure.

Alternatively, the depth (in the case of a region having a substantially cylindrical shape, the axial length) may be less than the thickness of the support structure. Accordingly, the bore in which the magnetic region resides may be in the shape of a cup, channel or block. In a preferred form the magnetic region and the bore in which it resides is cylindrical. The separation between magnetic regions may vary considerably depending on the application and is almost indefinable. For most applications, however, the distance separating the adjacent magnetic regions will fall within the range of 5-25mm, with 6-8mm preferred.

The plurality of magnetic regions may be orientated so that the north poles are co-planar. Alternatively, the magnetic regions may be grouped so that members within each group share the same pole in a common plane but have opposite poles to each

adjacent group. In yet another alternative, adjacent magnetic regions may have opposite poles whereby to maximise the magnetic field intensity of any particular point on the bearing surface of the magnetic holding device.

The insulating means may be made from a wide range of non-magnetic materials effective to insulate the support structure against direct magnetic leakage. Of course, a person skilled in the art will appreciate that some magnetic induction of the support structure will occur which may be desirable to enhance the distribution of magnetic field across the magnetic holding device without significant dissipation of magnetic flux beyond the magnetic regions.

The magnetic region may include a magnetic surface which lies close to or flush with the planar bearing surface. Preferably the magnetic surface lies flush with the planar bearing surface to maximise the magnetic force applied to a work piece, such as a steel backed die plate. Alternatively, the magnetic surface may lie just beneath the plane of the planar bearing surface to reduce the incidence of fatigue in the magnetic regions which may be sustained during a graphic art design process.

The insulating means may be made of any suitable non-magnetic material, for example, the insulating means may be made from non-magnetic metals such as copper, brass, zinc or aluminium, copper alloys, aluminium alloys, magnesium alloys, nickel, titanium, or from other materials including polymeric materials including tempered glass fibre, metal fibre, carbon fibre or graphite fibre.

The polymeric materials must necessarily possess high impact resistance characteristics and able to withstand relatively high temperatures up to around 160 to 210°C, more typically around 180°C. The polymeric material may include a thermoset resin selected from the group including allyl polymers, epoxy polymers, furan, melamine formaldehyde, melamine phenolic polymers, phenolic polymers, polybutyldiene polymers, thermoset polyester and alkyd polymers, thermoset polyamide polymers, thermoset polyurethane polymers, flexible thermoset silicone polymers, silicone epoxy polymers and thermoset ureapolymers. However, copper

alloy is a preferred material for forming the insulating means, due to its relative strength, the ease with which it may be worked, and its excellent magnetic insulation properties.

The insulating means may be in the form of a tube where the magnetic region extends from one face of the support structure through to its opposite face or in the form of a cup where the bore in which the region resides does not extend entirely through the support structure.

In the case where the insulating means is made from metallic material, heat distribution throughout the magnetic holding device may be relatively uniform. A support structure made of iron alloy is relatively poor heat conductor. Due to the relatively high resistance to heat transfer of iron alloys, the ultimate result is a uniform distribution of heat throughout the structure.

Where the insulating means is made from a non-magnetic metal or metal alloy such as copper, the heat transfer co-efficient of the material may be considerably higher than for that of the support structure generally made from an iron alloy. Accordingly, a uniform heat distribution may be obtained throughout the magnetic holding device effective for use, for example, in a hot stamping process.

In the case of non-metallic insulation means, heat transfer may occur between the support structure and the end surface of the magnetic region remote from the planar bearing surface, whereby uniform heat distribution is achieved throughout the magnetic holding device with the exception of the insulating means. It will be appreciated by persons skilled in the art that the effect of the insulating means being relatively colder than the rest of the magnetic holding device may be relatively minor and not sufficient to adversely effect the efficiency of a hot stamping process, particularly where the distance between the support structure and the magnetic region corresponding to the thickness of the wall of the insulating means is small.

The invention, in another broad form, also provides a method of manufacturing a magnetic holding device including at least one magnetic body located in a support structure, said method including the steps of:

a) forming at least one bore in said support structure, said support member being made from a hard iron alloy and having a substantially planar bearing surface;

b) inserting insulating means made from non-magnetic material into said bore, said insulating means defining a hole substantially coaxial with said bore; and

c) inserting the magnetic body into said hole,

wherein said insulating means is interposed between said magnetic body and said support structure to resist magnetic induction of, or leakage to, said support structure.

The invention, in yet another broad form, also provides a method of manufacturing a magnetic holding device including at least one magnetic body located in a support structure, said method including the steps of:

a) forming at least one bore in said support structure, said support structure being made from an iron alloy and having a substantially planar bearing surface;

b) inserting said body into insulating means to form an insulated body having an internal magnetic core surrounded by non-magnetic insulating means; and

c) inserting said insulated body into said bore, wherein said insulating means is interposed between said internal core and said support structure to resist magnetic induction of, or leakage to, said support structure.

The bore may be formed in the support structure by any one of a range of means familiar to the person skilled in the art. Preferably, the bore is formed by machining the support structure. The bore may extend entirely through the support structure or may extend part way through to form a recess. The magnetic body may be any shape or configuration such as block, square, rectangular or triangular shaped. However, the magnetic body is preferably cylindrical or disc-shaped, whereby the bore is correspondingly cylindrical or cup shaped.

The magnetic body may be inserted into the insulating means using a wide range of methods. For example, the magnetic body and the insulating means may be correspondingly threaded or otherwise grooved whereby to mutually engage. However, preferably the magnetic body is press fitted into the insulating means. Similar principles apply to the insertion of the insulated body into the bore. Preferably, the insulated body is press fitted into the bore, relying on the malleability of the insulating means to ensure a tight fit.

The insulating means may comprise bores which vary in thickness depending on the application. The insulating means wall must be sufficiently thick to provide effective resistance against magnetic induction occurring between the internal core and the support structure. Accordingly, the wall thickness of the insulating means may vary between 10μm and 3mm.

Preferably the bearing surface of the magnetic holding device is substantially smooth and planar. Accordingly, preferably the planar bearing surface is ground using a grinding machine to render the bearing surface substantially planar. Preferably the underside of the magnetic holding device is also ground to ensure a uniformly flat surface thereunder as well.

Brief Description of the Drawings

The invention shall be better understood from the following, non-limiting description of preferred forms of the invention, in which:

Figure 1 is a perspective view of a magnetic holding device according to one aspect of the invention;

Figure 2 is a top plan view of a magnetic holding device showing a range of possible arrangements;

Figure 3 is a side elevation of a magnetic holding device according to a first embodiment of the invention;

Figure 4 is a side elevation of a magnetic holding device according to a second embodiment of the invention; and

Figure 5 is a side elevation of a magnetic holding device according to a third embodiment of the invention.

Best Mode of Carrying out the Invention

It should be noted that the drawings are schematic and not drawn to scale.

Referring to Figure 1, there is shown a magnetic holding device 1 including a steel spacer plate 10 and a plurality of spaced magnets 20 arranged in a grid pattern.

The spacer plate 10 has a specific thickness whereby to act as a spacer in a hot stamping process involving the use of steel-backed photopolymer die plate 5 shown in dotted outline. The die plate 5 typically includes a thin sheet of steel adapted to be magnetically releasably fixed to the spacer plate 10 with the steel plate facing down and in direct contact with the spacer plate 10. The upper surface of the die plate 5 is coated with a polymeric material defining a design image for use in hot foil stamping. The die plate 5 is typically about 0.5 - 1.0mm thick. Consequently, the spacer plate 10 will be of a thickness of about 5.35 - 5.85mm in the US and 6.0 - 6.5mm elsewhere.

The support plate 10 is made from case-hardened steel making it extremely resistant to deformation on being subjected to repeated high impacts commonly

associated with hot stamping processes. Unlike the spacer plates of the prior art made from non-ferrous metal materials which are prone to deformation over time, the spacer plate 10 made of steel displays superior impact-resistant properties.

Each magnet 20 is insulated from the spacer plate 10 by insulating means 30. The insulating means 30 is made of a copper alloy which insulates the magnet 20 against magnetic inductance to the spacer plate 10. The insulating means 30 is in the form a tube of copper alloy having a wall thickness of about 1mm.

Due to the relative current day costs of steel compared to copper alloys or brass, there is a considerable cost advantage in making the spacer plate 10 out of steel. However, it is advantageous to surround the magnet 20 with albeit expensive copper alloy or another relatively soft non-magnetic metal because of its excellent magnetic insulation, maleability and heat transfer properties.

Referring to Figure 2, there is shown a magnetic holding device displaying a range of optional arrangements of permanent magnets 20. The different arrangements are presented on the one magnetic holding device 1 in order to conveniently describe the options available and it should be noted that any one magnetic holding device 1 would normally have the permanent magnets 20 arranged in a uniform pattern or array.

In the zone designated "A", there is shown nine large permanent magnets 21 arranged in a regular grid pattern in which each of the permanent magnets 21 are equi-spaced from the respective adjacent magnet 21.

The permanent magnets shown in zone "B" illustrate that a wide range of permanent magnet diameters and insulation means wall thicknesses may be suitable for different applications. Permanent magnets 22a may be moderate in size (for example, 6mm in diameter), and have insulation means 32 wall thickness of about 1mm.

Permanent magnets 22b may be larger in diameter, (for example, 10mm in diameter), and have insulating means 30 wall thickness as small as 10μm, provided that the integrity of the wall of the insulating means 30 is maintained and provides an effective barrier to direct magnetic inductance from the permanent magnet 22b to the spacer plate 10.

Magnets 22c illustrate that the magnets may be as small in diameter as 2mm and the insulation means wall thickness may be as large as 3mm. In general terms, magnetic field intensity is maximised by providing magnets 20 of small diameter in a closely spaced array. However, closely packed arrays may be labour-intensive to manufacture and costly in terms of materials.

As shown in zone "C" the permanent magnets 23 may be arranged in non-grid patterns or irregular arrays. In some applications, it may be helpful to have a central concentration of magnets 20 capable of securely holding a die plate 5 in position and to provide a less concentrated array of magnets 20 corresponding to the location of the peripheral edges of the die plate 5 to enable manipulation of the die plate 5.

Zone "D" illustrates that the orientation of the poles of the magnets 24 in a particular array may be important in maximising the magnetic force to be applied to the die plate 5. An array of magnets 24a with all negative poles orientated upwards is effective to induce positive polarity in the surrounding regions of the spacer plate 10 which will be referred to as the support structure 11. Conversely, arranging all positive poles of magnets 24b with an upward orientation is effective to induce negative polarity in the surrounding material of the support structure 11. As will be appreciated, the material of the surrounding support structure 11 is only weakly induced due to the effective resistance to same by the insulation means 30.

The strongest magnetic flux field in the region of an array of magnets 24c is obtained by alternating their polarities such that, at the bearing surface 12 (refer to Figure 3) the polarity of each magnet 24c is opposite to the polarity of each

adjacent magnet in the array. Such alternating polarity increases the complexity of the weakly induced magnetic polarity surrounding each magnet 24c, such that the weakly induced polarity of the material of the support structure 11 immediately surrounding each magnet 24c is opposite to the polarity of that magnet 24c.

With reference to Figure 3 there is shown a first preferred embodiment of the magnetic holding device of the invention in which the bores into which each shrouded magnet 20 is inserted extends completely through from the bearing surface 12 to the underside surface 13 of the magnetic holding device 1. Figure 3 further illustrates the arrangement of magnets 20 in which the magnetic polarities are alternatingly oppositely orientated whereby to weakly induce the immediately surrounding support structure 11 to correspondingly have the opposite polarity. The shape of the magnetic field 14 is schematically illustrated in Figure 3 as an "opposed ear-shaped" configuration affecting the polarities of the weakly induced regions of the support structure 11.

In Figure 4 there is shown a second embodiment of the invention in which the sheathed magnets 20 are retained in cup-like bores which do not extend right through the support structure 11. It is preferred in this embodiment that the insulating means 30 is made from a metallic material such as copper alloy or brass to ensure adequate heat transfer from the support structure 11 to the regions occupied by the magnets 20 to ensure uniform and effective heat transfer to the die plate 5 in a hot stamping process.

Figure 5 shows a third embodiment in which the magnets 20 are retained in bores which do not extend entirely through the support structure 11 but form a recess for the magnets 20 to reside therein. In this embodiment the insulating means 30 is in the form of a tube 30 which insulates only the side walls of the disc-shaped magnet 20.

The strength of the magnets 20 is expressed in terms of the amount of magnetic flux available from a unit volume of the magnet material and is generally described

in units of MGOe (mega gauss orsted). As the person skilled in the art will appreciate, a range of magnetic materials may be used. Where hot stamping processes are involved requiring efficacy of the magnet material at temperatures around 140°-160° Celsius, it is important that the material have superior heat remanence properties in this temperature range. Such materials include samarium cobalt ($SmCo^{17}$) having an MGOe of 16-32 and neodymium-iron-boron (MdFeB) with an MGOe of 24-48. $SmCo^{17}$ is most preferred because of its low temperature of remanence which makes it suitable for operation at higher temperatures such as those associated with hot foil stamping processes.

In operation the spacer plate 10 may be carefully aligned on the chase of a hot foil stamping machine (not shown). The spacer plate may have recesses (not shown) on each of its four underside edges. Non-alignment of the spacer plate 10 may be corrected with the aid of an industrial fork adapted to coact with one of the recesses to disengage the spacer plate 10 from the chase and permit re-alignment. The die plate 5 may then in turn be carefully aligned on the spacer plate's bearing surface 12. After the production run is carried out the die plate 5 may generally be removed by hand. The magnetic forces retaining the spacer plate 10 on the chase require the use of the industrial fork to effect its removal from the chase as mentioned above.

Industrial Applicability

The invention has industrial applicability at least in relation to the graphic arts industry, and more particularly, in relation to the releasable attachment of steel-backed die plates to such machines.

Throughout the specification the word "comprise" and its derivatives is intended to have an inclusive rather than exclusive meaning unless the context requires otherwise.

It will be apparent to those skilled in the art that many modifications and variations may be made to the embodiments described herein without departing from the spirit or scope of the invention.

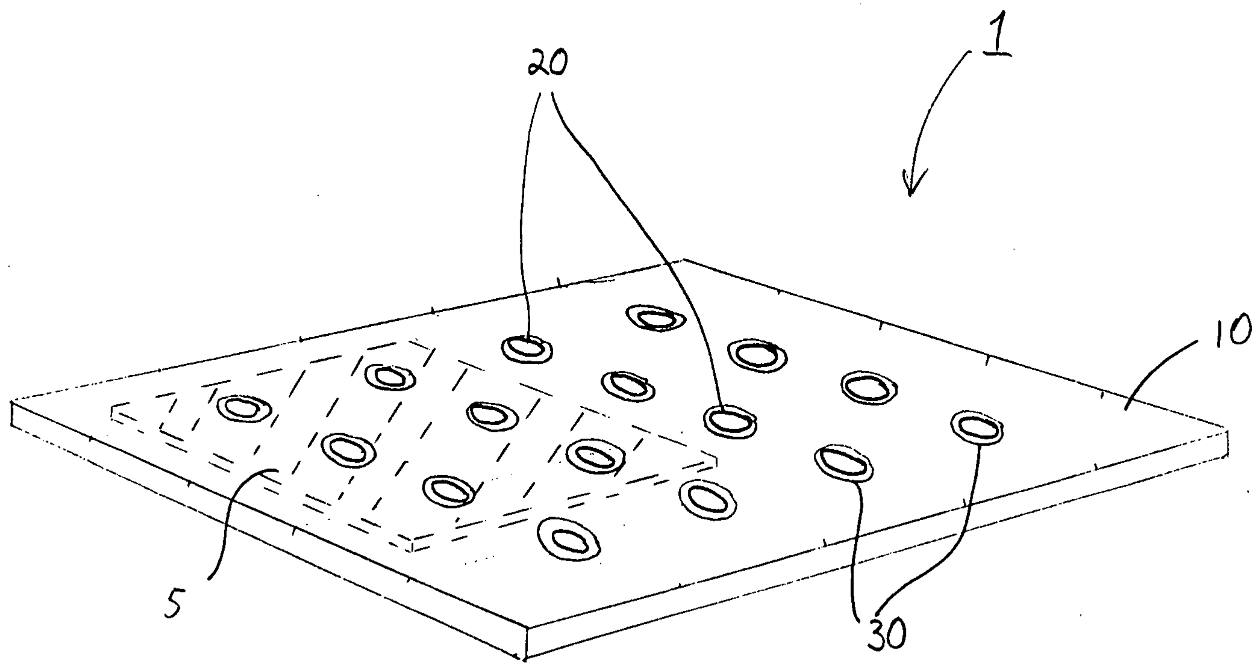

Figure 1

Figure 2

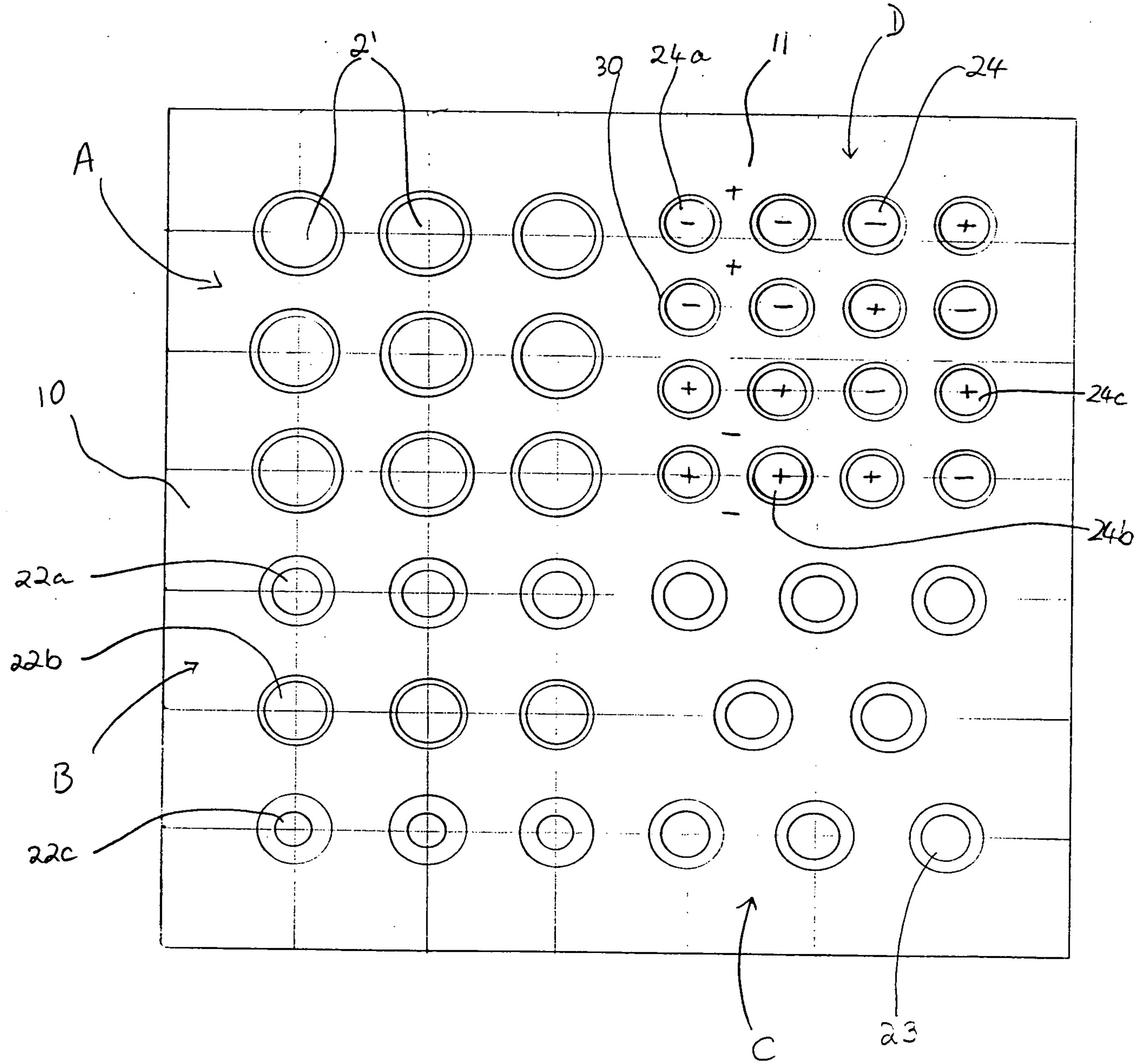

Fig 3

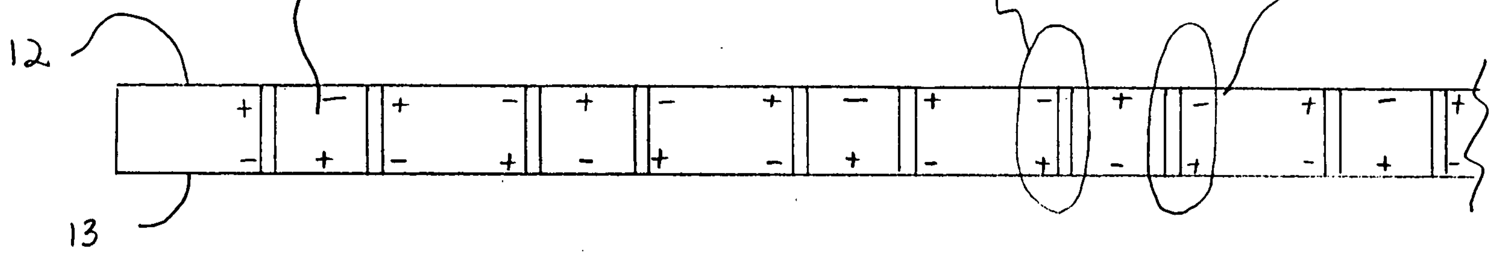

Fig. 4

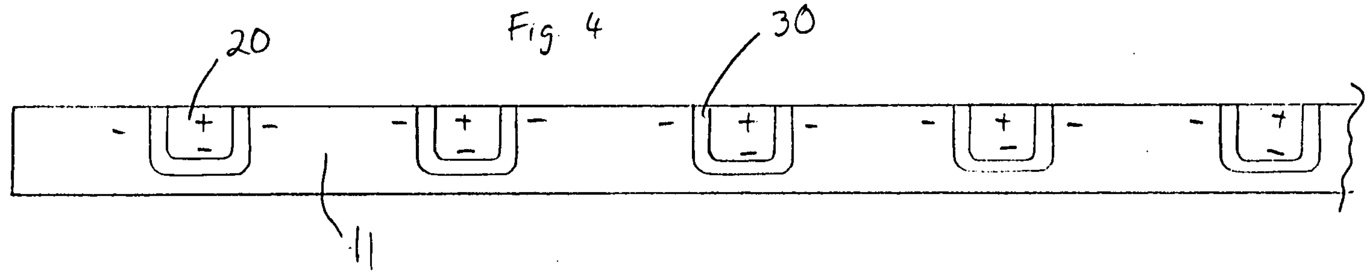

Fig. 5